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10/594717

IAP2 Rec'd PCT/PTO 29 SEP 2005

MODULAR STRUCTURE**FIELD OF THE INVENTION**

The present invention relates broadly to a constructional module and a structure including a plurality of constructional modules. The invention further relates generally to a method
5 of construction and relates particularly, though not exclusively, to a method of building construction including roof truss construction.

BACKGROUND OF THE INVENTION

Buildings that can be deployed quickly and efficiently are commonly required for example in military use. Such temporary structures are typically used in establishing a base camp
10 and include buildings for accommodation, workshops, control facilities, amenities and as equipment stores. Further, some buildings are required to have large clear spans in the order of 20m or more to house for example major equipment such as aircraft, and vehicles. As the structures often are located in remote areas and need to be assembled in hostile conditions, there is a continuing need to provide such redeployable structures that can be
15 erected and disassembled more effectively.

Improvements in material technology and construction methodology have allowed large redeployable structures to be transported and erected. Newer technologies such as air-supported structures have evolved but require mechanical equipment, pumps, fuel etc to maintain and are understood not to be well regarded for expeditionary type roles. For
20 larger structures suitable for heavy machinery, aircraft and the like, tent-like solutions do not scale particularly well.

SUMMARY OF THE INVENTION

According to one aspect of the present invention there is provided a constructional module being adapted to engage one or more other corresponding constructional modules to form a
25 structure, said module being of a predetermined configuration and adapted to cooperate with one or more conditioning elements wherein the structure is configurable depending on the relative positioning of the modules and/or deployment of the conditioning elements.

According to another aspect of the invention there is provided a structure comprising:

- a plurality of constructional modules being of a predetermined configuration; and
- one or more conditioning elements being arranged to cooperate with the constructional modules wherein adjacent of said modules engage one another to form the structure which is configurable depending on the relative positioning of the modules and/or deployment of the conditioning elements.

Preferably the constructional module is of a composite construction. More preferably the composite constructional module is fabricated from a fibre composite material such as a particulate filled resin material with high strengths fibre reinforcement, or a polyester resin based material. Alternately the constructional module is formed from a polymeric material and may, for example, be pultruded.

Preferably the constructional module is shaped in the form of a trapezium including upper and lower substantially parallel chord members being interconnected at opposite ends with respective web members. More preferably each of the constructional modules is of a substantially identical shape. Even more preferably the chord and web members are formed as hollow section members, for example square hollow section (SHS) members. Still more preferably the trapezium-shaped constructional module includes a pair of diagonal web members arranged to add rigidity to the module.

Preferably the conditioning elements are each in the form of tendons wherein deployment of said elements is effected by stressing of the tendons. More preferably the tendons are designed to locate within the hollow section of the lower and/or upper chord member, and stressing of the tendons involves pre-stressing or post tensioning of the tendons and the corresponding chord member. Even more preferably the lower chord only includes one or more of the tendons. Alternately, and to provide additional rigidity to the structure, both the upper and the lower chord members include said tendons which for example suit the structure to higher load applications such as typhoonic/cyclonic wind.

Preferably the constructional module includes interlocking means being arranged to provide interlocking of the adjacent modules. More preferably the interlocking means includes an integral spigot being adapted to engage a hole of an adjacent module, or *vice versa*, and designed to permit pivotal movement between adjacent of said modules on

deployment of the conditioning elements. Even more preferably the spigot or hole allows a hinged action between said adjacent modules. Still more preferably the spigot and/or hole together with the surrounding portion of the constructional module is reinforced. Alternatively the interlocking means at top chord level includes a pivotal or hinged
5 connector such as a clevis/pin type arrangement.

Preferably the structure also comprises packer elements being designed to locate between adjacent of the constructional modules to effect reconfiguration of the structure.

Preferably the structure is a building structure, and in particular a roof truss. More preferably each of the constructional modules is a truss module.

10 Preferably the roof truss is clad with elongate and transversely oriented sheeting. More preferably the sheeting is of a channel section and fabricated of a rigid material including a plastic such as PVC or ABS, or metallic material. Alternately the cladding is made from a fabric such as canvas.

Preferably the structure is redeployable.

15 According to a further aspect of the invention there is provided a method of construction, said method including the steps of:

providing a plurality of constructional modules each being of a predetermined configuration, and one or more conditioning elements being arranged to cooperate with said modules;

20 locating the modules adjacent one another and positioning the conditioning elements to permit engagement of said adjacent modules; and

deploying the conditioning elements wherein the modules are together configured to form a structure.

Preferably the conditioning elements are each in the form of tendons and the step of
25 deploying the conditioning elements involves stressing of the tendons. More preferably this involves pre-stressing or post tensioning of the tendons which effects deployment of the structure. Even more preferably the structure is a roof truss and stressing of the tendons provides erection of the roof truss.

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25 deploying the conditioning elements involves stressing of the tendons. More preferably this involves pre-stressing or post tensioning of the tendons which effects deployment of the structure. Even more preferably the structure is a roof truss and stressing of the tendons provides erection of the roof truss.

Figure 7 shows in perspective and sectional views an end wall of the redeployable roof structure of figure 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

As best shown in figure 1 there is a building or shelter system 10 comprising a series of structures or in this embodiment modular frames 12A to 12F being arranged generally parallel to and laterally spaced from one another, and interconnected with in this example, roof sheeting designated generally as 14. The modular frames such as 12A are each in their erected condition in the form of a roof truss each including a plurality of constructional modules or in this example truss modules or panels such as 16A and 16B.

As shown in figure 3A each of the truss panels such as 16A is shaped in the form of a trapezium including upper and lower substantially parallel chord members 18 and 20, respectively, which are interconnected at opposite ends with web members 22 and 24. The truss panel 16A also includes a diagonally oriented web member 26 which provides additional rigidity to the truss panel 16A. Alternatively the diagonal web member 26 is one of a pair of diagonal web members which together form an "X". Each of the truss panels such as 16A of this embodiment are of a substantially identical profile shape and constructed of a composite material with the chord and web members being of a hollow section. For example, the lower chord 20 of the truss panel 16A as shown in the detailed sectional view of figure 3 is formed as a square hollow section (SHS) having an internal void 28. Figure 3B illustrates three (3) alternate constructional modules or panels each having solid webs rather than the diagonal web member 26 of the previous embodiment. In order to avoid repetition, and for ease of reference, like components of this embodiment have been designated with an additional "0", for example the truss panel 160.

The composite material from which the constructional modules of this embodiment are formed is a particulate filled resin (PFR) material which permits the truss panels to be cast or moulded. This provides a lightweight and robust material which is relatively easy to manufacture and the PFR has a reduced amount of expensive high strength fibres such as kevlar and carbon fibre but rather relies upon a low cost filler to provide robustness, placement and protection to the fibres somewhat analogous to reinforced concrete where the higher strength steel reinforcement is positioned and protected by the concrete filler.

An alternate technique is for the truss panels such as 16A or other constructional modules to be "pultruded" from a composite material. In this alternate example the module is fabricated from separate sections, each pultruded from a composite material and fixed together.

- 5 As shown in figures 2A to 2F the truss panels such as 16A and 16B of this embodiment are of the predetermined trapezium configuration so that on engagement, or in this case abutment, with one another they together form the building structure or module frame such as 12A. In the examples of figures 2A to 2F the modular frame such as 12A is
- 10 configurable depending on the number and relative positions of the truss panels such as 16A and 16B or other constructional modules. In this embodiment the structure or modular frame such as 12A includes packer elements (not illustrated) located between adjacent truss panels such as 16A and 16B to adapt the modular frame such as 12A for different span, height and pitched roof structures 10. The packer elements are designed to locate in the space between adjacent lower chord members such as 20 of adjacent truss
- 15 panels such as 16A and 16B to adjust the spacing between modules or panels 16A/B and hence the geometry of the modular frame 12A.

- The structure or modular frame 12A of this example also includes conditioning elements arranged to cooperate with the constructional modules or truss panels such as 16A and 16B to form the modular frame 12A. In this case the conditioning elements include tendons
- 20 which locate within the hollow section of the upper and/or lower chord member 18 or 20 of adjacent and abutting truss panels such as 16A and 16B. This is best illustrated in figure 4 where the conditioning element or lower tendon 28 passes through adjacent lower chord members 20A and 20B of adjacent and abutting truss panels 16A to 16C. As will later be described in more detail, the conditioning means or lower tendon 28 is deployed or in this
- 25 example stressed or tensioned to facilitate cooperative movement of the truss panels such as 16A and 16B and as such erection of the modular frame 12A.

- The adjacent constructional modules or truss panels 16A and 16B each include interlocking means arranged to provide interlocking of the panels 16A and 16B when in this example they are in abutting engagement. The interlocking means in this construction
- 30 of the constructional modules includes a protrusion or integral spigot such as 30A and 30B located at adjacent ends of the upper and lower chord members 18 and 20, respectively.

An opposite end of each of the upper and lower chord members 18 and 20 includes a respective hole 32A and 32B which interlocks with the spigots of the adjacent constructional module or truss panel (see figures 3A and 4). This spigot/hole connection permits pivotal movement between adjacent of the modules or truss panels such as 16A and 16B which on erection of the modular frame 12A provides a hinged action at this connection or abutment of the upper chord members such as 18. The constructional module or truss panels are preferentially reinforced about the surrounding portion of the spigot and recess such as 30A and 32A. Alternately, the connection between the modules or truss panels at top chord level is provided by a pivotal or hinged connector. This connector (not shown) may be in the form of a clevis/pin type arrangement.

As best shown in figure 6 the roof structure 10 is clad with elongate and transversely oriented sheeting being of a trough or channel configuration such as 34A to 34F. The roof cladding of this embodiment is fabricated from a rigid plastic material such as PVC or ABS. The roof cladding 34A is substantially half the width of the top chord member such as 18 and of a sufficient length to extend between adjacent modular frames such as 12A and 12B with a butted or lapped connection between the cladding. Adjacent of the roof cladding panels such as 34A and 34B are connected to one another so as to provide a connection which permits hinging action during erection of the modular frame such as 12A. The roof structure 10 may also be lined with a flexible membrane 36 such as a canvas membrane which seals the cladding 34A to 34C from water and dust. The roof structure 10 may also include an insulation or ballistics board 38 which underlies the flexible membrane 36 and sits across the roof cladding such as 34B. In an alternate construction the roof cladding may include a flexible membrane alone such as a fabric covering for example canvas.

As shown in figure 7 there is an end wall designated generally as 40 formed in this example from wall panels of an identical construction to the roof cladding panels such as 34A. The wall panels such as 42A and 42B are, in a similar fashion to the roof cladding panels, of a standard length, such as 6 metres. The wall panels span vertically from ground level to the roof line, and the roof cladding panel overhang together with purpose shaped infills provide some measure of closure to the building. At ground the wall panels may be set in a trench and backfilled to provide support, and the depth of embedment allows for

effective adjustment of length of the wall panels. Walls panels may also be lapped if the standard length is insufficient to vertically span from ground to the roof line. A door opening such as 44 can be supported via a bolted lintel 46.

The roof structure 10 is particularly well suited to applications where it can be redeployed.

- 5 These applications include but are not limited to deployable hangars for the various military forces and ideally are suited to roof structures having spans of up to around 35 metres but more often around 15 metres. Redeployable and modular roof structures such as those described in the preceding paragraphs are well suited to these applications where deployment considerations are transportation, relatively fast set up and disassembly.
- 10 The general steps involved in constructing the roof structure 10 of the preceding example are as follows:
1. as best shown in figure 5A, the constructional modules or truss elements such as 12A are located alongside one another in a collapsed or flat condition together with the conditioning means or lower tendon 28 threaded through lower chord members
15 such as 20A and 20B;
 2. as further shown in figure 5A, the roof structure 10 includes an adjustable support module such as 48A and 50A located at respective opposing ends of the modular frame 12A with one of the support panels such as 48A being anchored;
 3. as best shown in figure 5B, the conditioning means or tendon 28 is deployed or
20 tensioned wherein the constructional modules or in this example trapezium-shaped truss panels are hinged relative to one another whereupon the modular frame 12A is progressively raised whilst the other adjustable support panel 50A slides inwardly toward the anchored support panel 48A; and
 4. as best shown in figure 5C, the modular frame or truss structure 12A is
25 progressively moving to its erected condition with the adjacent constructional modules or truss panels such as 16A and 16B of this example abutting one another whereupon the floating support panel 50A is anchored.

This mode of construction enables the modular frame to move from its collapsed condition to its erected condition largely as a function of the geometry of the constructional modules and their mode of connection in conjunction with the conditioning means or in this example the tendons such as 28. The trapezium-shaped truss panels such as 16A and 16B have a shorter lower chord member 20 than the upper chord member 18, and the outer web members 22 and 24 taper toward one another so that each constructional module or truss panel such as 18A has mutually inclined outer side bearing surfaces. It will be appreciated that the respective outer bearing surfaces of the truss panels such as 16A and 16B in the collapsed condition are spaced apart except at their upper portion whereas on erection of the modular frame such as 12A the bearing surfaces are substantially in abutment with one another. However, as will be appreciated from figures 2A to 2F the spacer elements may be utilised to vary this degree of abutment and thus the configuration of the structure or modular frame such as 12A.

Without wanting to be limited by shapes and/or dimension, the following table provides sizes for the roof trusses of figures 2A to 2F. The thickness of the spacer elements or packers located between adjacent modules or truss panels such as 16A and 16B are also given.

Modular Frame	Width (m)	Height (m)	Packer thickness (mm)	No. of truss panels
Figure 2A	35.23	11.112	No packer	32
Figure 2B	19.669	8.5	No packer	20
Figure 2C	35.189	12.5	80	32
Figure 2D	53.05	15.0	120	44
Figure 2E	30.714	9.0	80	26
Figure 2F	38.643	10.0	100	30

Now that a preferred embodiment of the present invention has been described in some detail, it will be apparent to those skilled in the art that at least the preferred embodiment of the constructional module/structure and method of construction have at least the following advantages:

- 5 1. The constructional modules are relatively compact and lightweight and as such lend themselves to redeployable structures;
2. The structure being of a modular design can be erected with relative ease requiring minimal tools and trade skills;
3. The structure is reconfigurable by varying the relative positions of the
10 constructional modules, using a different number of modules, and/or varying the deployment of the conditioning elements;
4. The structure can be adapted for differing conditions and for example include additional conditioning elements in the form of tendons arranged along the upper chord of for example the truss frame;
- 15 5. The structure can be assembled at ground level and then erected using the conditioning elements which for example are tensioned, and as such this method of deployment minimises safety requirements for working at heights;
6. The structure and associated building system provides a relatively large clear span roofing system;
- 20 7. The structure and constructional modules have a minimum number of loose components but rather include "captive" components which avoid loss in adverse conditions;
8. The constructional modules of the structure permit compact storage and transportation, for example the modules may be fully containerised in standard
25 freight containers transported by air, road, rail or sea; and

9. The structure is formed largely from components which are identical and as such there are a minimum number of components to handle and inventorize, and it is easier and more manageable to have spares.

Those skilled in the art will appreciate that the invention described herein is susceptible to variations and modifications other than those specifically described. For example, the constructional modules may be shaped differently to the trapezium-shaped truss panels of the described embodiment. The panels need not be limited to a composite construction but for example they extend to other preferably lightweight materials such as aluminium alloy, or alternatively steel. Similarly, the roof cladding may be constructed of any suitable material although high pressure thermoformed (HPT) plastics such as PVC are preferred. The building structure may in military applications include passive or active means to reduce the radar signature of the redeployable structure and any contained equipment. Ideally, the shelter system materials will provide a minimised radar signature and it is expected that special coverings may be able to actively shield the internal equipment. Otherwise, it is preferable that the structure or in the described embodiment redeployable building system includes environmental conditioning systems (heating/cooling) and ventilation, is capable of chemical agent decontamination using standard procedures when erected, can provide blackout capability, and/or provides camouflage capability. The structure need not be limited to the roof truss described but may for example extend to bridges and other structures.

All such variations and modifications are to be considered within the scope of the present invention, the nature of which is to be determined from the foregoing description.

Claims

1. A constructional module being adapted to engage one or more other corresponding constructional modules to form a structure, said module being of a predetermined configuration and adapted to cooperate with one or more conditioning elements wherein
5 the structure is configurable depending on the relative positioning of the modules and/or deployment of the conditioning elements.
2. A structure comprising:
a plurality of constructional modules being of a predetermined configuration; and
one or more conditioning elements being arranged to cooperate with the
10 constructional modules wherein adjacent of said modules engage one another to form the structure which is configurable depending on the relative positioning of the modules and/or deployment of the conditioning elements.
3. A constructional module or a structure as defined in either of claims 1 or 2 respectively wherein the constructional module is of a composite construction.
- 15 4. A constructional module or a structure as defined in claim 3 wherein the composite constructional module is fabricated from a fibre composite material.
5. A constructional module or a structure as defined in claim 4 wherein the fibre composite material is a particulate filled resin material with high strengths fibre reinforcement, or a polyester resin based material.
- 20 6. A constructional module or a structure as defined in either of claims 1 or 2 respectively wherein the constructional module is formed from a polymeric material.
7. A constructional module or a structure as defined in claim 6 wherein the polymeric material is pultruded.
8. A constructional module or a structure as defined in any one of the preceding
25 claims wherein the constructional module is shaped in the form of a trapezium including upper and lower substantially parallel chord members being interconnected at opposite ends with respective web members.

9. A constructional module or a structure as defined in claim 8 wherein each of the constructional modules is of a substantially identical shape.
10. A constructional module or a structure as defined in either of claims 8 or 9 wherein the chord and web members are formed as hollow section members.
- 5 11. A constructional module or a structure as defined in claim 10 wherein the hollow section members are square hollow section (SHS) members.
12. A constructional module or a structure as defined in any one of claims 8 to 11 wherein the trapezium-shaped constructional module includes a pair of diagonal web members arranged to add rigidity to the module.
- 10 13. A constructional module or a structure as defined in any one of the preceding claims wherein the conditioning elements are each in the form of tendons wherein deployment of said elements is effected by stressing of the tendons.
14. A constructional module or a structure as defined in claim 13 wherein the tendons are designed to locate within a hollow section of a lower and/or upper chord member, and
- 15 15. stressing of the tendons involves pre-stressing or post tensioning of the tendons and the corresponding chord member.
16. A constructional module or a structure as defined in claim 14 wherein the lower chord only includes one or more of the tendons.
17. A constructional module or a structure as defined in claim 14 wherein to provide
- 20 18. additional rigidity, both the upper and the lower chord members include said tendons.
17. A constructional module or a structure as defined in any one of the preceding claims wherein the constructional module includes interlocking means being arranged to provide interlocking of the adjacent modules.
18. A constructional module or a structure as defined in claim 17 wherein the
- 25 19. interlocking means includes an integral spigot being adapted to engage a hole of an adjacent module, or *vice versa*, and designed to permit pivotal movement between adjacent of said modules on deployment of the conditioning elements.

19. A constructional module or a structure as defined in claim 18 wherein the spigot or hole allows a hinged action between said adjacent modules.
20. A constructional module or a structure as defined in either of claims 18 or 19 wherein the spigot and/or hole together with the surrounding portion of the constructional module is reinforced.
21. A constructional module or a structure as defined in any one of the preceding claims further comprising packer elements being adapted to locate between adjacent of the constructional modules to effect reconfiguration of the structure.
22. A constructional module or a structure as defined in any one of the preceding claims wherein each of the constructional modules is a truss module.
23. A structure as defined in any one of the preceding claims wherein the structure is a building structure.
24. A structure as defined in claim 23 wherein the building structure is a roof truss clad with elongate and transversely oriented sheeting.
25. A structure as defined in claim 24 wherein the sheeting is of a channel section and fabricated of a rigid material.
26. A structure as defined in claim 24 wherein the cladding is made from a fabric.
27. A structure as defined in any one of the preceding claims wherein the structure is redeployable.
28. A method of construction, said method including the steps of:
providing a plurality of constructional modules each being of a predetermined configuration, and one or more conditioning elements being arranged to cooperate with said modules;
locating the modules adjacent one another and positioning the conditioning elements to permit engagement of said adjacent modules;

deploying the conditioning elements wherein the modules are together configured to form a structure.

29. A method as defined in claim 28 wherein the conditioning elements are each in the form of tendons and the step of deploying the conditioning elements involves stressing of
5 the tendons.

30. A method as defined in claim 29 wherein stressing of the tendons involves pre-stressing or post tensioning of the tendons which effects deployment of the structure.

31. A method as defined in either of claims 29 or 30 wherein the structure is a roof truss and stressing of the tendons provides erection of the roof truss.

10 32. A method as defined in any one of claims 28 to 31 wherein the method of construction also involves the ability to, if required, reconfigure the structure by placement of packer elements between adjacent of the constructional modules.

33. A method as defined in claim 32 wherein this reconfiguration step is effected prior to deployment of the conditioning elements.

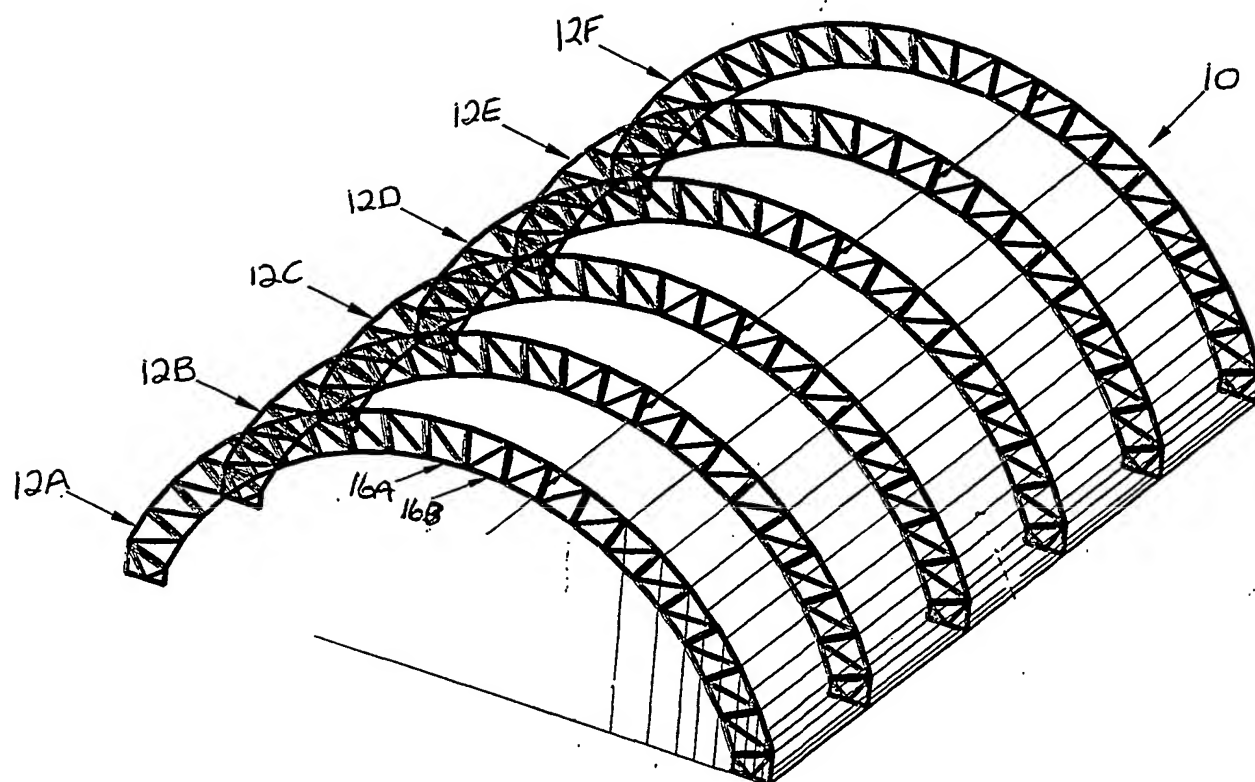


FIGURE 1

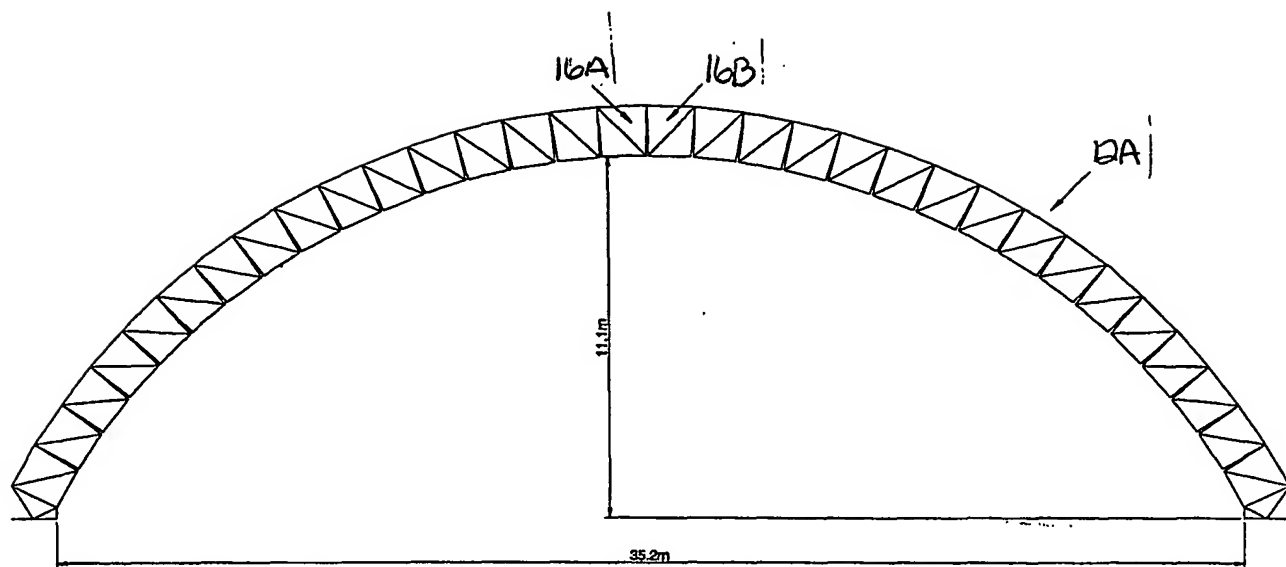


FIGURE 2A

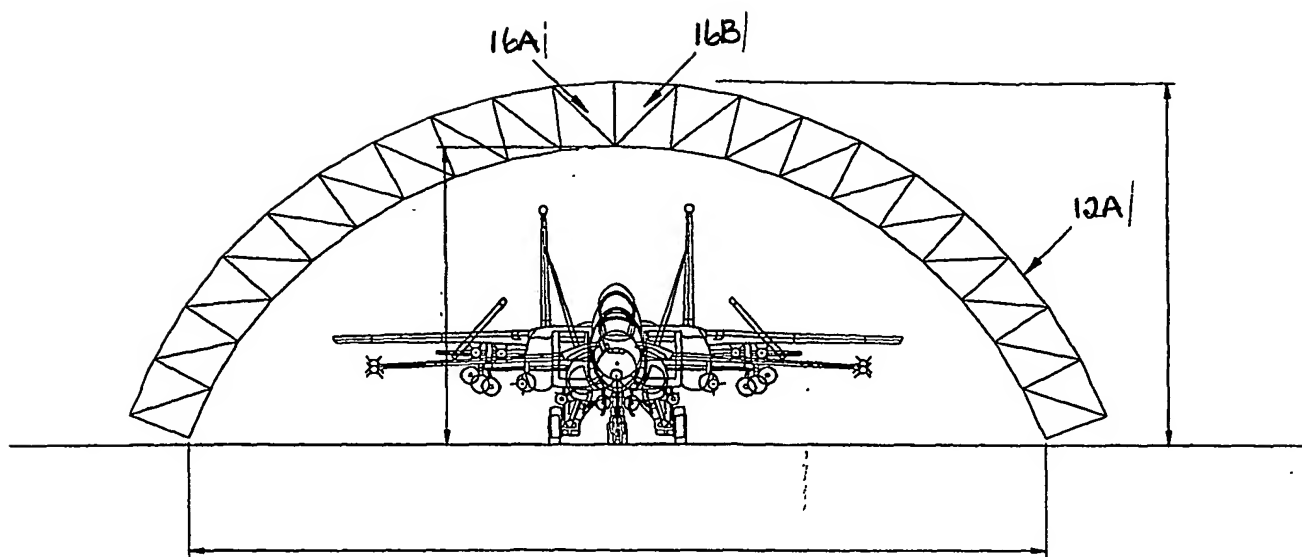


FIGURE 2B

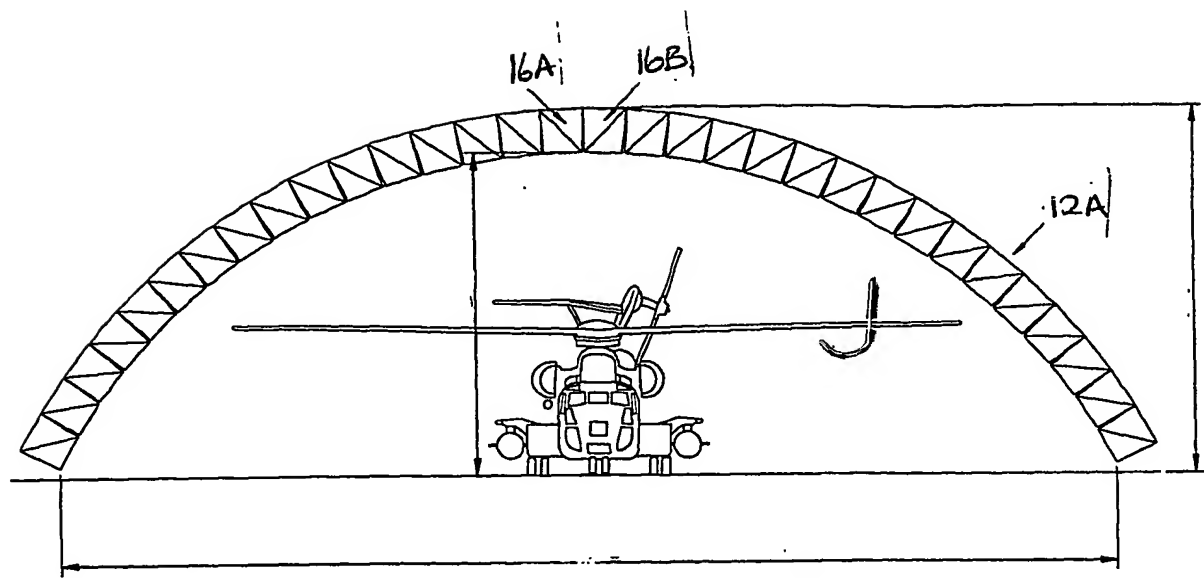


FIGURE 2C

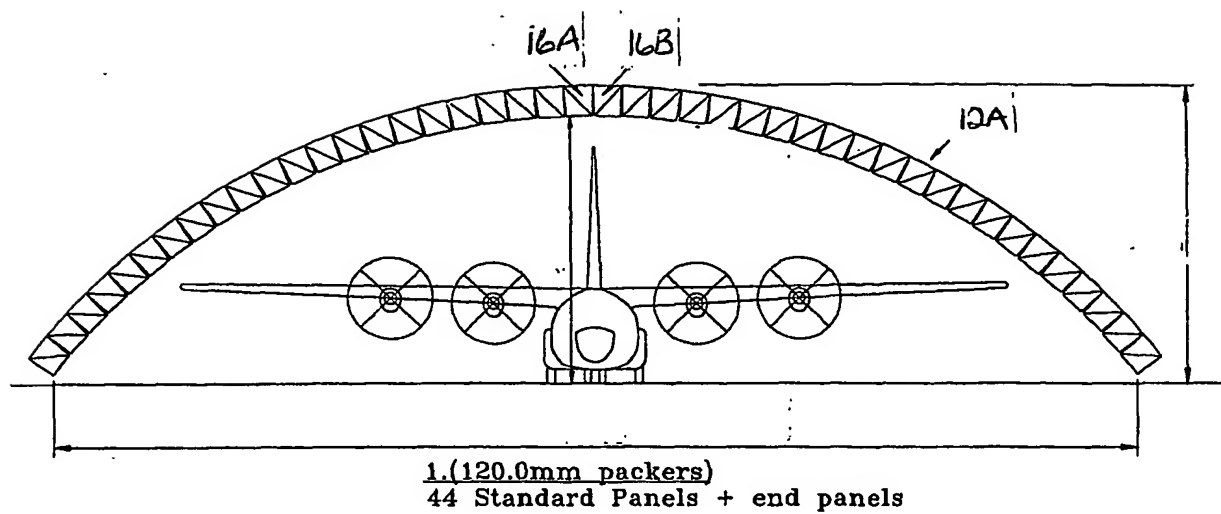


FIGURE 2D

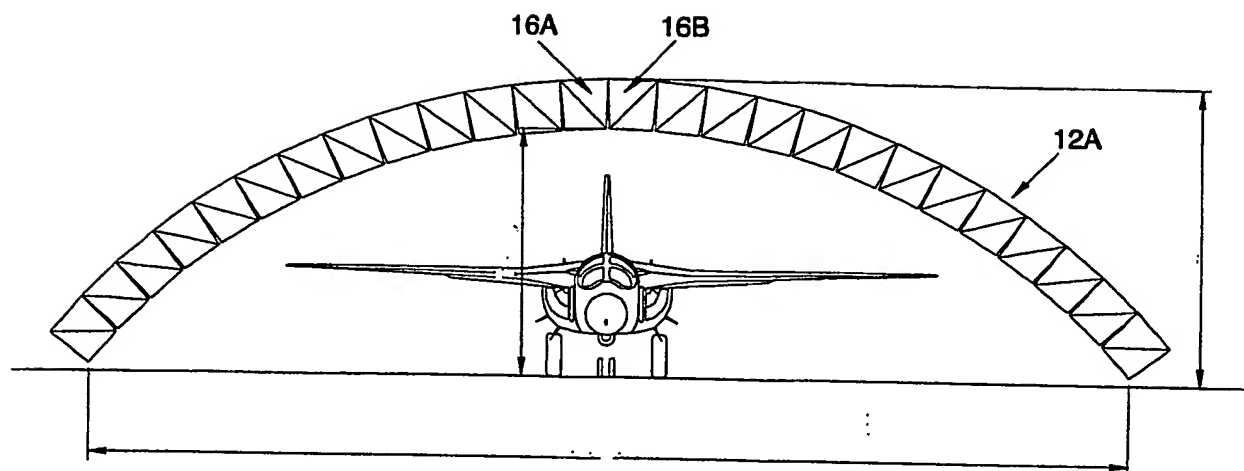


FIGURE 2E

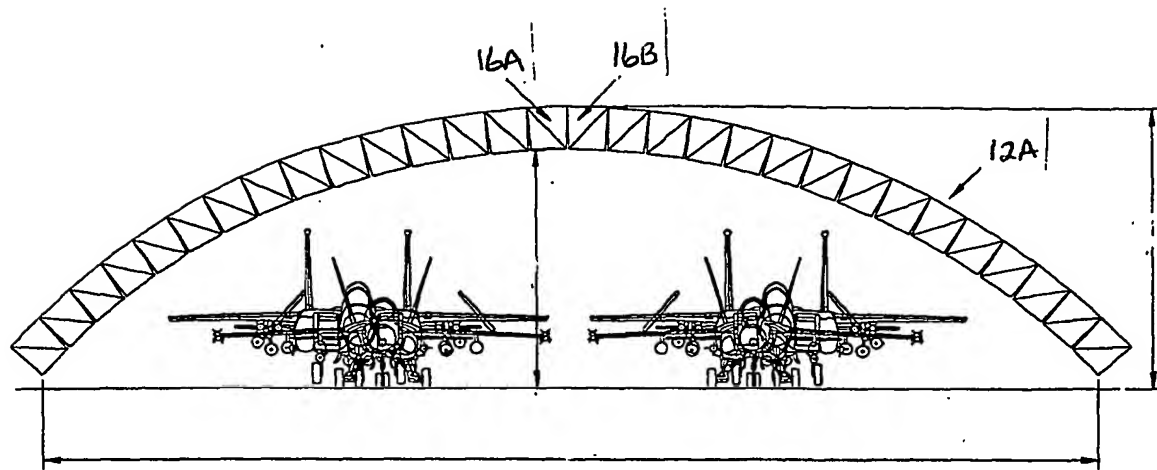


FIGURE 2F

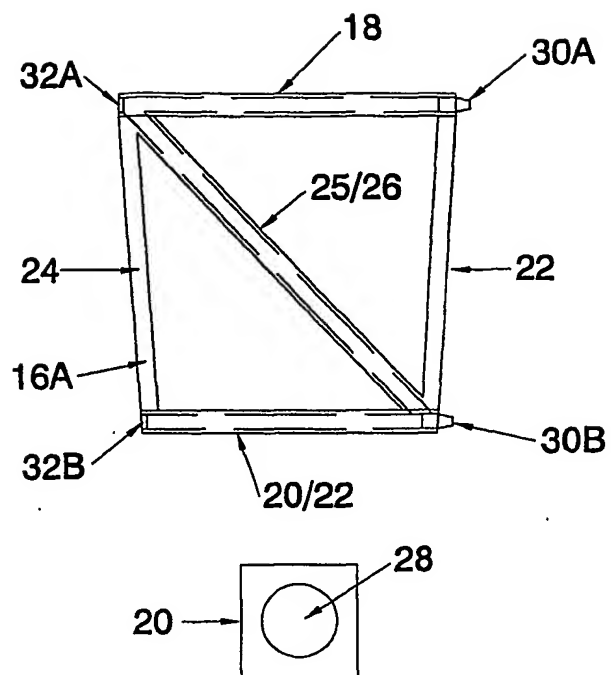


FIGURE 3A

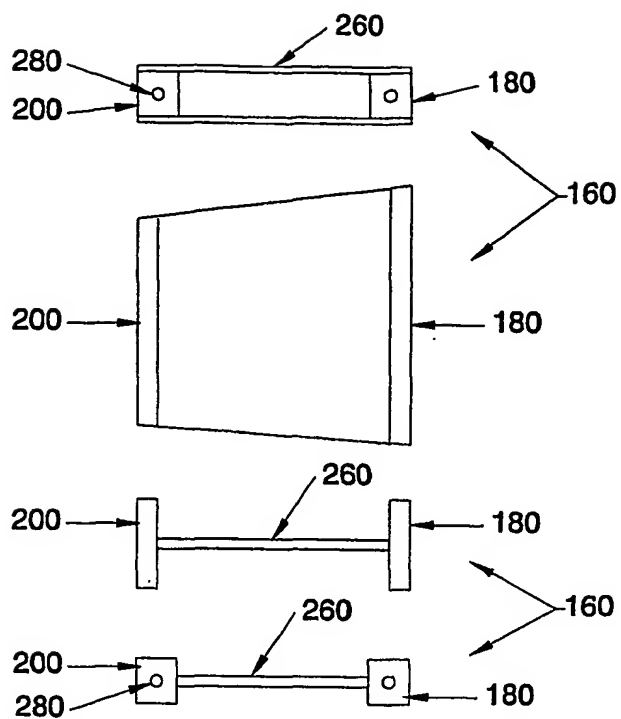


FIGURE 3B

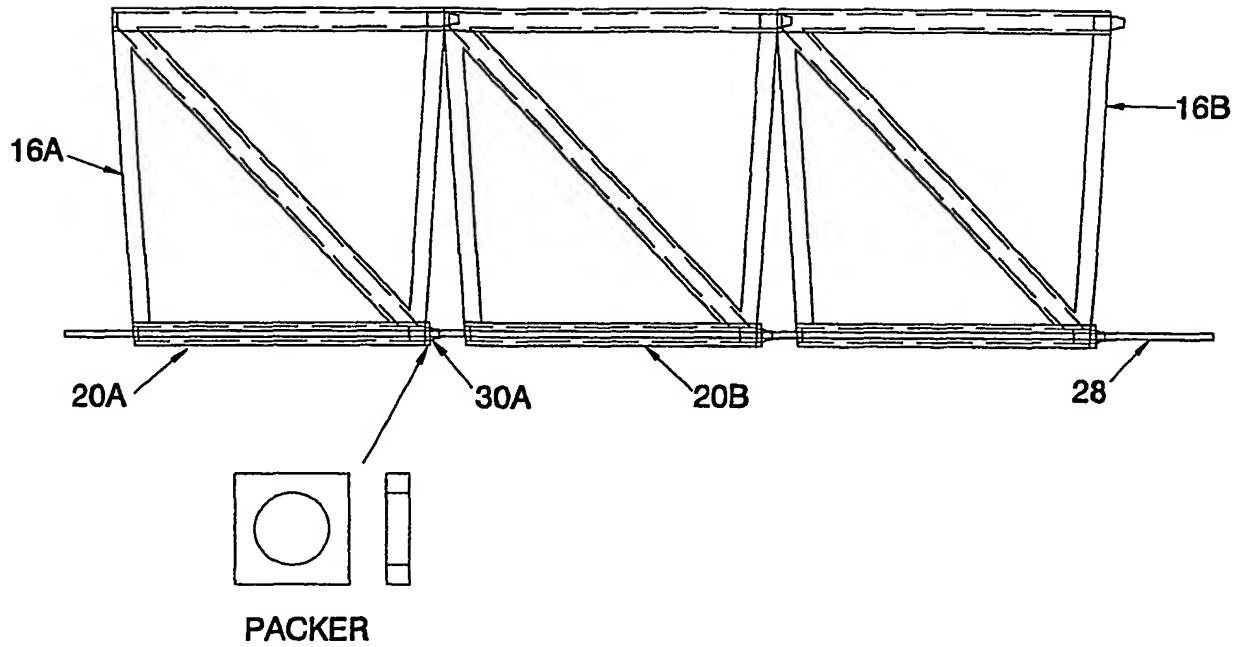


FIGURE 4

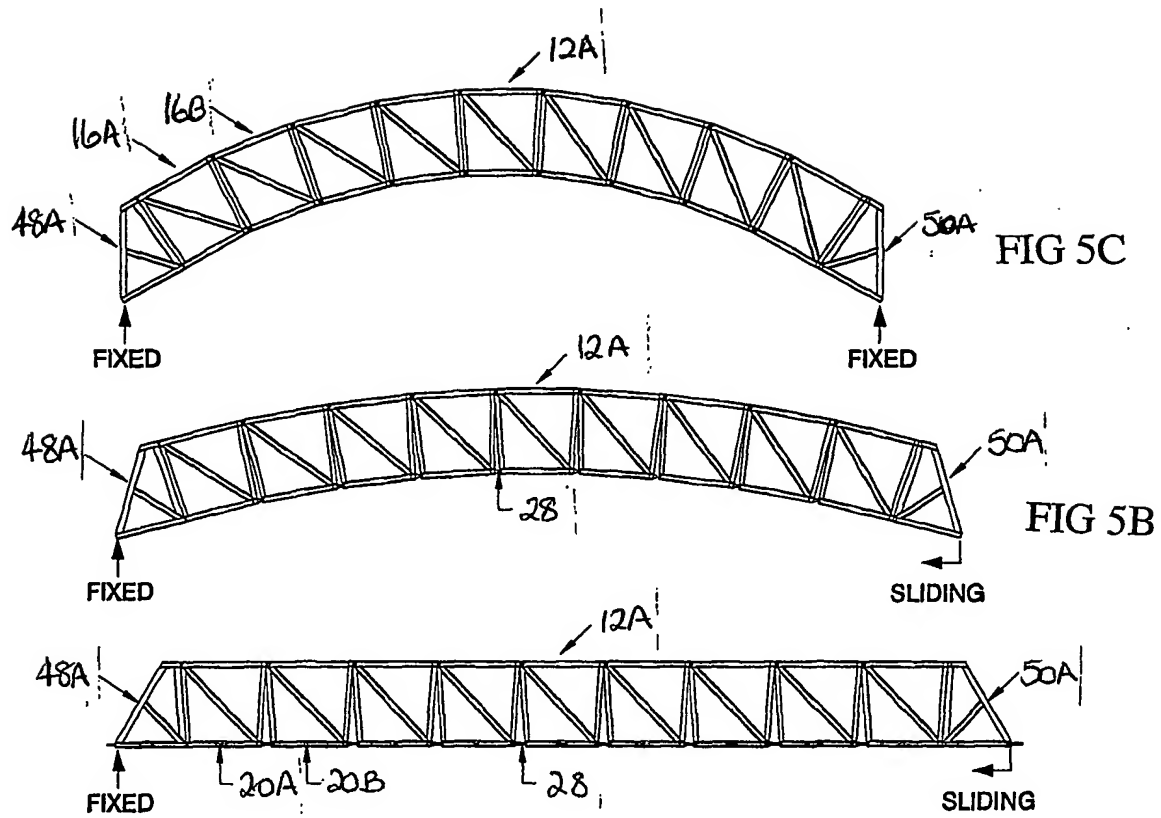


FIGURE 5A

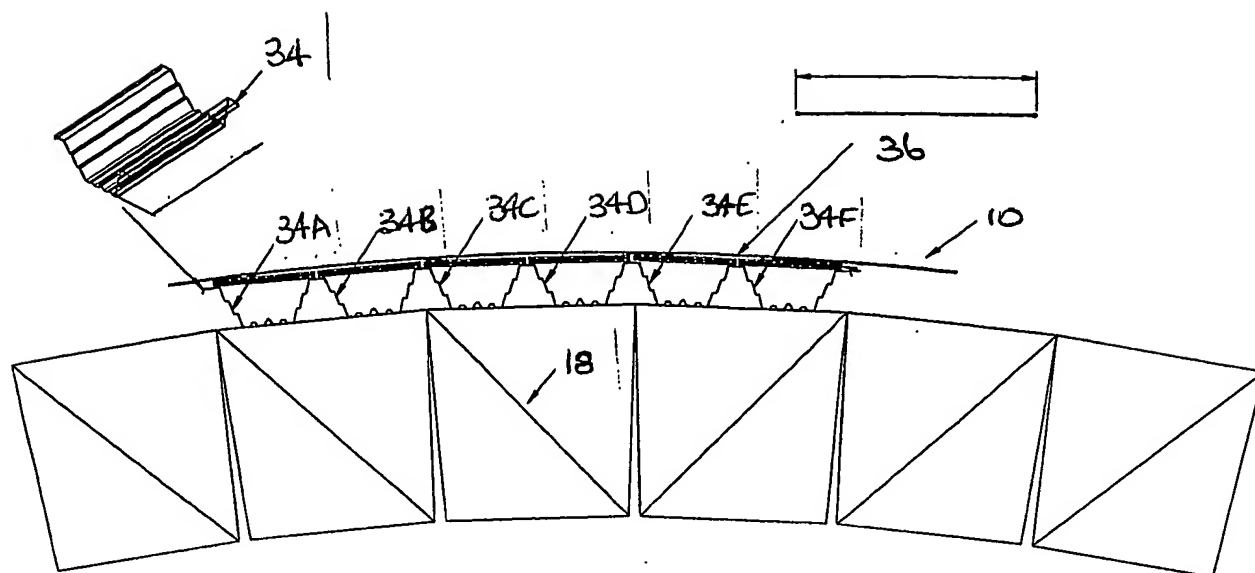


FIGURE 6

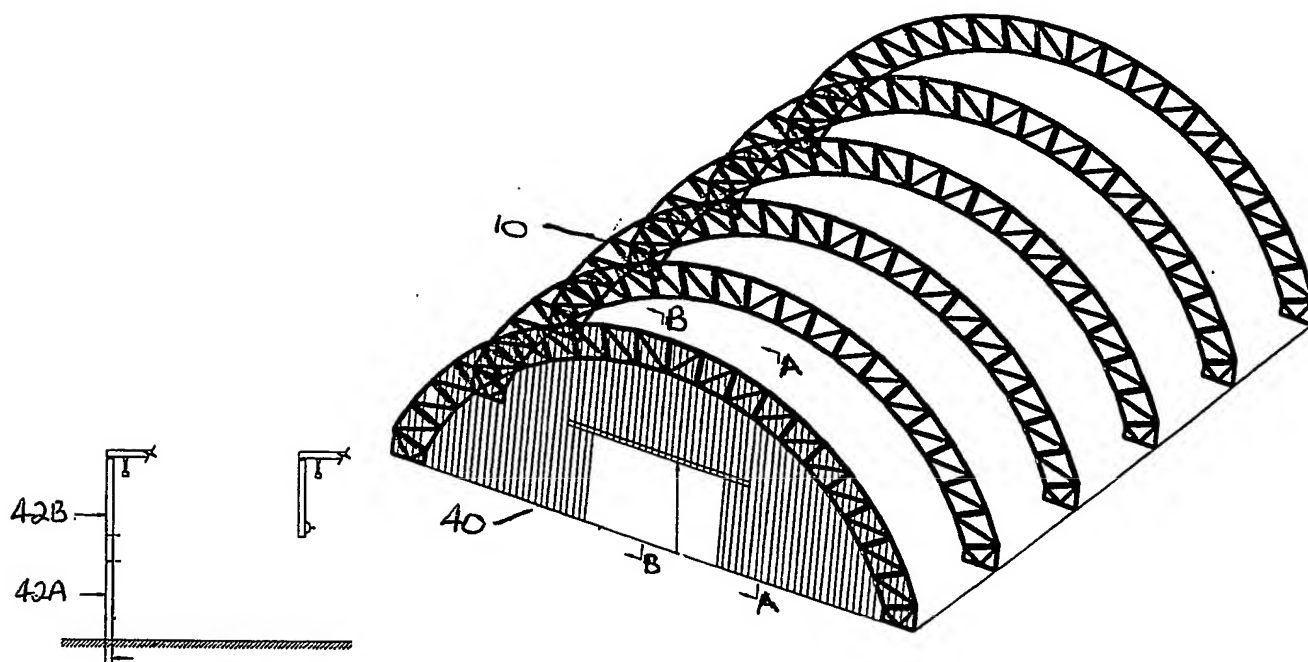


FIGURE 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU2005/000463

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. ⁷: E04B 1/32, 1/342, E04C 3/38, 3/10, 3/28, E04H 6/44, 15/36

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

REFER TO ELECTRONIC DATABASE BELOW

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

DWPI: & keywords: E04B/ic, E04C/ic, E04H/ic, truss, tendon, tension, arc, hinge, and similar terms.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 2167783 A (ELSPAN INTERNATIONAL LTD (HONG KONG)) 4 June 1986 See figures 1a-10, and column 2 line 96 – column 3 line 20.	1-15, 17-20, 22-31
X	WO 1996/001930 A1 (WEATHER-HAVEN RESOURCES LTD et al.) 25 January 1996 See figures 1-5 and page 5 lines 4-16 and page 10 lines 1-22.	1-13, 17-33
X	US 3940892 A (LINDBERGH) 2 March 1976 See figures 1-3b, column 3 line 53 – column 4 line 48, column 5 lines 6-34.	1-13, 17-20, 22-31
X	GB 1355984 A (PORTAS) 12 June 1974 See page 2 line 16-page 3 line 5 and figures 1-21.	1-13, 17-20, 22-31



Further documents are listed in the continuation of Box C



See patent family annex

* Special categories of cited documents:	
"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search
17 May 2005Date of mailing of the international search report
24 MAY 2005

Name and mailing address of the ISA/AU

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU2005/000463

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2985264 A (LEONARD, JR) 23 May 1961 See figures 1-6.	1-12, 17, 22-23, 27-28
X	WO 1992/018730 A1 (DOWTY HOYBOND LIMITED et al.) 29 October 1992 See figures 1-5.	1-11, 13, 17-20, 22-31
X	US 4894962 A (CONN) 23 January 1990 See figures 1-7, column 3 line 38-column 4 line 44 and column 5 lines 12-22.	1-8, 13-15, 17-33
X	WO 1995/020079 A1 (NOBELIUS) 27 July 1995 See figures 1-5.	1-7, 13-17, 21-33
X	DD 289081 A5 (VEB BAUINVEST DRESDEN) 18 April 1991 See figures 1-6.	1-7, 13, 17-23, 27-33.
X	US 3857213 A (MIYAKE) 31 December 1974 See figures 1-17, 25-28.	1-9, 13-14, 21-33
X	WO 2003/078739 A1 (CHRISTIE) 25 September 2003 See figures 1a-6b.	1-7, 17-23, 27-28, 32-33
X	GB 1484236 A (ELSPAN INTERNATIONAL LIMITED) 1 September 1977 See figures 1-5 and page 2 lines 16-104.	1-7, 13-15, 17, 22-31

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/AU2005/000463

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member			
GB	2167783	AU	48450/85	CA	1250729
		JP	61134447	US	4676045
WO	9601930	AU	28781/95		
US	3940892	NIL			
GB	1355984	NIL			
US	2985264	NIL			
WO	9218730	AU	15381/92	CA	2079935
		GB	2254630	EP	0542940
US	4894962	CA	2005160		
WO	9520079	AU	15949/95	CA	2181991
		NO	962799	PL	315549
DD	289081	NIL			
US	3857213	DE	2053412	US	3708944
WO	2003078739	NIL			
GB	1484236	AU	10786/76	PH	13494
				US	4052834

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

END OF ANNEX

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